REMARKS

Claims 1-16 are pending in this application. By this Amendment, claims 2 and 12 are amended. These amendments are supported by Applicants' specification at least at, page2, lines 25-30 and page 6, lines 11-15. Claim 16 is added. No new matter is added. Reconsideration of the application based on the above amendments and the following remarks is respectfully requested.

The courtesies extended to Applicants' representatives by Examiner Chang during the telephone interview held June 10, 2009 are appreciated. The reasons presented during the telephone interview as warranting favorable action are incorporated into the remarks below, which constitute Applicants' record of the interview.

The Office Action objects to claims 2-4 and 12. Claims 2 and 12 are amended to recite Benton H1 and Benton H2 to obviate this objection. H1 and H2 are terms well known in the art and when combined with the name of the inventor the Stephen Benton are not ambiguous, as evidenced by the attached excerpt from a textbook on the subject which is referred to on page 6, lines 11-15 of Applicants' disclosure. Withdrawal of the objection to claims 2 and 12 is respectfully requested.

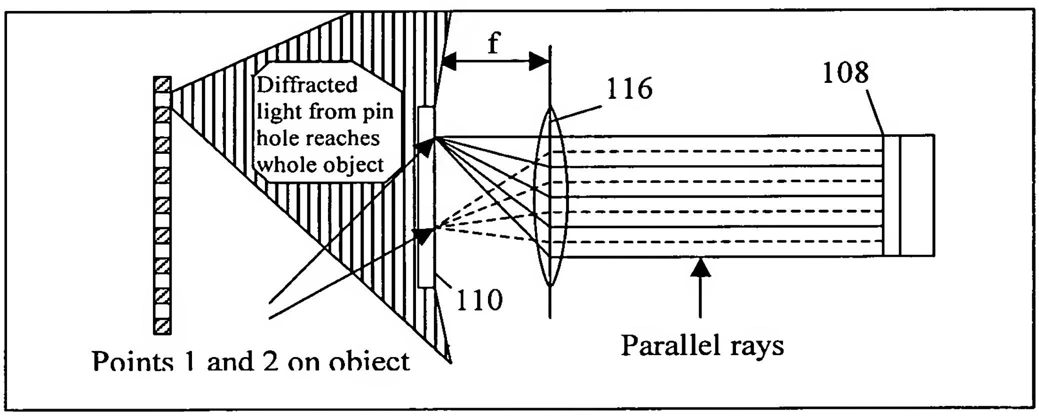
The Office Action rejects claims 1, 2, 9 and 10 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 3,749,469 to Gayeski et al. (hereinafter "Gayeski"). This rejection is respectfully traversed.

Claim 1 recites, among other features, wherein an aperture mask is located upstream or downstream of the object with respect to the direction of the diffuse light beam such that different parts of the object are imaged on to respective different, non-overlapping parts of the record medium.

The Office Action asserts that pinhole array 114 of Gayeski corresponds to the above aperture mask including all of the above features. Gayeski teaches at, *e.g.*, col. 2, lines 43-51.

that the wave energy passing through pinhole array 114 will be diffracted thereby and Object 110 is situated as shown at an appropriate distance from pinhole array 114 to be spatially sampled with a sufficiently high resolution by the diffracted wave energy from pinhole array 114 incident thereon, further that wave energy from each pinhole in pinhole array 114 illuminates the entire object 110. Thus, Gayeski teaches light from every pinhole reaches every part of object 110.

Further Gayeski teaches object 110 at the focal point of lens 116. Thus, as shown for two object points in the figure below, light spreading from each point on the object 110 will be converted to parallel rays after passing through the lens 11 and light from every point on the object 110 will reach every part of hologram recording medium 108.



Thus, as discussed during the telephone interview, pinhole array 114 of Gayeski cannot reasonably be considered to correspond to an aperture mask located such that different parts of the object are imaged on to respective different, non-overlapping parts of the record medium, because as shown above all parts of the object 110 are imaged on all parts of hologram recording medium 108.

During the telephone interview the Examiner asserted that the features recited in claim 1 are insufficient to have formed an aperture mask located such that different parts of the object are imaged on to respective different, non-overlapping parts of the record medium. The Examiner asserted, with reference to related art Fig. 1 that, Fig. 1 shows a single aperture

3. The Examiner further asserted that Fig. 5, which shows an embodiment of Applicants' disclosure, requires two apertures. Related art Fig. 1, does not disclose any apertures, merely three image elements, A_1, A_2 and A_3 (see, *e.g.*, page 8, lines 13-24 of Applicants' specification). Similarly, Fig. 5, an embodiment of Applicants' disclosure, discloses only a single aperture 9 and three image elements, A_1, A_2 and A_3 (see, e.g., page 10, lines 3-30 of Applicants' specification). Thus, Applicants' specification discloses a single aperture in the embodiment shown in Fig. 5, and no aperture in the related art shown in Fig. 1.

For at least the foregoing reasons, Gayeski cannot reasonably be considered to teach the combination of all of the features positively recited in claim 1. Further, Gayeski cannot reasonably be considered to teach the combinations of all of the features recited in claims 2, 9 and 10 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 1, 2, 9 and 10 under 35 U.S.C. §102(b) as being anticipated by Gayeski are respectfully requested.

The Office Action rejects claims 1, 2, 5 and 6 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 3,891,975 to Deml et al. (hereinafter "Deml"). This rejection is respectfully traversed.

Claim 1 recites, among other features, exposing an object to a coherent beam of diffuse light, causing the resultant light to interfere with a reference beam, and recording the resultant interference pattern on or in a record medium.

As discussed during the telephone interview, the Office Action asserts that second beam 134 of Deml corresponds to a reference beam. Deml teaches at, *e.g.*, col. 8, lines 48-67, that, as shown in FIG. 11, a laser beam that is split into a first beam 133 and a second beam 134 by means of a semitranslucent mirror 132. Deml teaches further that the second beam 134 impinges upon a mirror 135 that reflects it through hologram 110 onto a photoreceiver

136. Deml does not teach the second beam 134 interfering with any light from an object. Further, Deml does not teach the recording of any interference pattern produced by the second beam 134. Deml does not teach recording any result of interfering any two beams of light, because Deml merely teaches a method to extract and record the phase distribution from a previously formed Hologram (see, *e.g.*, col. 1, lines 6-16 and col. 1, lines 30-32).

For at least the foregoing reasons, Deml cannot reasonably be considered to teach the combination of all of the features positively recited in claim 1. Further, Deml cannot reasonably be considered to teach the combinations of all of the features recited in claims 2, 5 and 6 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 1, 2, 5 and 6 under 35 U.S.C. §102(b) as being anticipated by Deml are respectfully requested.

The Office Action rejects claims 3, 4, 11 and 12 under 35 U.S.C. §103(a) as being unpatentable over Deml in view of U.S. Patent No. 5,973,807 to Buchkremer et al. (hereinafter "Buchkremer"). This rejection is respectfully traversed.

The Office Action concedes that Deml does not teach the object for recording the hologram is comprised of a sequence of steps in a moving image or movement being recorded. The Office Action asserts that Buchkremer remedies these shortfalls of Deml. As argued above, Deml cannot reasonably be considered to have suggested the combination of all of the features recited in claim 1. Buchkremer, as applied to claim 1, does not remedy the above-discussed shortfalls in the application of Deml to the subject matter of claim 1. Therefore, the combination of Deml with Buchkremer cannot reasonably be considered to have suggested the combinations of all of the features recited in claims 3, 4, 11 and 12 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 3, 4, 11 and 12 under 35 U.S.C. 103(a) as being unpatentable over Deml in view of Buchkremer are respectfully requested.

The Office Action rejects claims 7 and 8 under 35 U.S.C. §103(a) as being unpatentable over Deml in view of Buchkremer and further in view of U.S. Patent No. 5,121,229 to Benton. This rejection is respectfully traversed.

The Office Action concedes that Deml and Buchkremer do not teach the bar shaped aperture being extended transverse to the object for creating color variation. The Office Action asserts that Benton remedies these shortfalls of Deml and Buchkremer. As argued above, Deml cannot reasonably be considered to have suggested the combination of all of the features recited in claim 1. Buchkremer and Benton, as applied to claim 1, do not remedy the above-discussed shortfalls in the application of Deml to the subject matter of claim 1. Therefore, the combination of Deml with Buchkremer and Benton cannot reasonably be considered to have suggested the combinations of all of the features recited in claims 7 and 8 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 7 and 8 under 35 U.S.C. 103(a) as being unpatentable over Deml in view of Buchkremer further in view of Benton are respectfully requested.

The Office Action rejects claims 9 and 10 under 35 U.S.C. §103(a) as being unpatentable over Deml in view of Gayeski. This rejection is respectfully traversed.

The Office Action concedes that Deml does not teach that the apertures are pinholes or of rectangular shape. The Office Action asserts that Gayeski remedies the above-discussed shortfalls of Deml. As argued above, neither of Deml and Gayeski, separately, can reasonably be considered to teach, or to have suggested, the combination of all of the features

recited in claim 1. Further, the combination of Deml and Gayeski cannot reasonably be considered to have suggested the combination of all of the features recited in claim 1. Therefore, the combination of Deml with Gayeski cannot reasonably be considered to have suggested the combinations of all of the features recited in claims 9 and 10 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 9 and 10 under 35 U.S.C. §103(a) as being unpatentable over Deml in view of Gayeski are respectfully requested.

The Office Action rejects claims 13-15 under 35 U.S.C. §103(a) as being unpatentable over Gayeski in view of U.S. Patent No. 5,535,023 to Yamazaki; and under 35 U.S.C. §103(a) as being unpatentable over Deml in view of Yamazaki. These rejections are respectfully traversed.

The Office Action concedes that Gayeski and Deml, separately, do not teach a security device that includes the hologram and a banknote or certificate of authenticity. The Office Action asserts that Yamazaki remedies the above-discussed shortfalls of Gayeski and Deml. As argued above, Gayeski and Deml, separately, cannot reasonably be considered to have suggested the combination of all of the features recited in claim 1. Yamazaki, as applied to claim 1, does not remedy the above-discussed shortfalls of Gayeski and Deml. Therefore, the combination of Gayeski with Yamazaki and Gayeski cannot reasonably be considered to have suggested the combinations of all of the features recited in claims 13-15 for at least the dependence of these claims on allowable base claims, as well as for the separately patentable subject matter that each of these claims recites.

Accordingly, reconsideration and withdrawal of the rejection of claims 13-15 under 35 U.S.C. §103(a) as being unpatentable over Gayeski in view of Yamazakiand Deml in view of Yamazaki are respectfully requested.

Added claim 16 is allowable at least for its dependence on an allowable base claim, as well as for the separately patentable subject matter that this claims recites.

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-16 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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Registration No. 27,075

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JAO:MIL/add

Attachments:
Petition for Extension of Time
Excerpt from "Practical Holography" Second Edition by Graham Saxby ©1994

Date: July 8, 2009

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PRACTICAL HOLOGRAPHY

SECOND EDITION

GRAHAM SAXBY

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Chapter 18

ACHROMATIC AND PSEUDOCOLOR HOLOGRAMS

A large rose-tree stood near the entrance of the garden: the roses growing on it were white, but there were three gardeners at it, busily painting them red.

LEWIS CARROLL, *Alice in Wonderland*

The word *achromatic*†, as used in this chapter and subsequently, means 'colorless'; an achromatic image is an image that appears in shades of neutral gray instead of being in a single color ('monochromatic'). As the term 'rainbow hologram' is inappropriate for an achromatic image, the term *white-light transmission (WLT) hologram*† will be used.

Image-plane Achromatic Holograms

We have seen that a transmission image that is wholly in the plane of the hologram will not alter in shape, size or position when illuminated by light of different wavelengths, because the focal length of the hologram is zero. Any image-plane WLT hologram (either full-aperture or focused-image) will give an achromatic image when replayed by white light, provided the original subject was shallow. This is not true of rainbow holograms, of course, or of the usual kind of reflection hologram, as both of these are wavelength-selective. However, it is possible to process dichromated-gelatin (DCG) reflection holograms to produce near-achromatic images: the appropriate processing technique produces varying fringe spacing, known as *chirped fringes*†, resulting in a very wide-band reconstruction (see Chapter 20).

Making an ordinary rainbow hologram produce an achromatic image requires a different, though still simple, approach. If you replay the hologram using a vertical line source such as a long-filament lamp, the filament will act as an array of point sources, each producing its own spectrum. The spectra will overlap so that at a central viewing point they will add to form an achromatic image (Fig. 18.1).

This works well enough for shallow images. For deeper images the change in image size and position with wavelength produces color fringing at the edges of the image, and it becomes obvious that the image is unsharp in the horizontal direction. However, it works well for small images, as you can see if you hold a credit card under a fluorescent tube oriented "vertically" to the little security hologram.

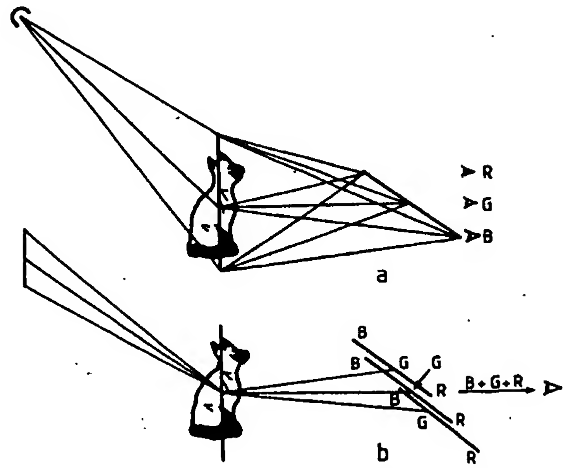

Fig. 18.1 Achromatic viewing of a rainbow hologram. (a) Conventional point-source illumination produces a tilted spectrum providing monochromatic viewing. (b) A vertically extended source provides overlapping spectra which add to provide an achromatic image at the central viewing position. For the sake of clarity, only the primary green rays are shown. Distances and angles are not to scale.

Dispersion Compensation

It has been asserted more than once that there is no way of looking at the image of a laser transmission hologram by white light. That is not strictly true. As early as 1966, Dominic DeBitetto[1] proposed a technique called 'dispersion compensation' which operated in much the same way as the correction of chromatic aberration† in camera lenses, by introducing an equal and opposite dispersion. This was investigated by Bazargan,[2] and for a time a device for displaying transmission holograms was marketed (see also Chapter 25). The principle is simple enough. You make a holographic diffraction grating using the exact geometry of your proposed hologram, but with a point source replacing the subject (Fig. 18.2). You take the grating, rotate it through 180°, and place it in contact with the hologram. When you illuminate the grating with a white-light source at the original object position, that is, the position of the point source you used to make the grating, the diffracted light will produce an image which is in exactly the same position, and the same size, for every wavelength in the spectrum.

There is one small snag, however. The direct beam from the replay source is full in your eyes. However, a remedy is available. 3M produces a material called 'Light Control Film', which is essentially a miniature venetian blind, which you can obtain in sheets that let light through only at an angle of incidence of around 45°. When this material is sandwiched between the diffraction grating and the hologram it blocks off the beam (Fig. 18.3).

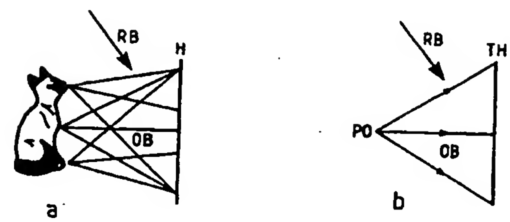

Fig. 18.2 To make a dispersion compensation grating you need to make a trivial hologram (TH), i.e. a hologram of a point object at the center of the subject matter of the original hologram.

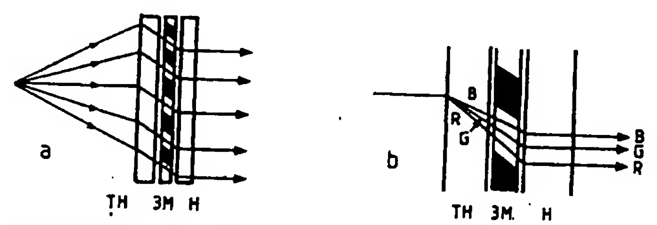

Fig. 18.3 Dispersion compensation. By spinning the trivial hologram of Fig. 18.2, the optics are reversed, and the dispersion is precisely compensated for the central portions of the subject. An interposed sheet of 3M 45° Light Control Film prevents the zero-order beam from emerging. (a) shows the overall effect, (b) the detail. Angles and dispersions are exaggerated for clarity.

The Achromatic Angle for Transmission Masters

In 1977 Stephen Benton surprised holographers by exhibiting a WLT hologram of a sculptured head of Aphrodite that was completely colorless when illuminated with a small-source white light (Plate 11). The method was subsequently patented.[3] He had used a specially produced and very complicated HOE which generated a large number of virtual images of slits, each in its geometrically correct position to produce a final image in which the spectra overlapped in register. This work has proved difficult to replicate, and Benton himself said that if ever the diffractor plate were broken, the team wouldn't be prepared to go through the hassle of recreating it. As it happened, the research led to a much simpler idea which is now used universally for making achromatic and full-color holograms with good registration. The concept is known as the *achromatic angle*†.

The principle of the achromatic angle is so simple that it seems odd that nobody thought of it before — but that always seems to be the case when someone has a brilliant intuition. The achromatic angle is the angle the real image of the spectrum makes with the normal to a rainbow hologram. We have already met it under the guise of the 'tip angle'.

In 1982, Benton[4] outlined the mathematics associated with the production of display

WLT holograms. Soon afterwards, Suzanne St Cyr[5] produced a lengthy analysis of the practical applications of Benton's mathematics, culminating in a worksheet for producing holograms to meet specific viewing demands. Both papers appear, with the authors' permission and are abridged where appropriate, in Appendix 4. The first full derivation of the principle of the achromatic angle is in a paper by Benton[6] on reflection holographic stereograms, discussed more fully in Chapter 19.

When a WLT hologram is made from a transmission master using collimated beams throughout, the real image of the slit will be at a distance in front of the (flipped) final transfer that is equal to the spacing between the master and final holograms (Fig. 18.4).

If the replay beam is collimated white light, the red slit will be focused in the same position, but the rest of the spectrum will be spaced out along a sloping curve that is almost a straight line. The angle α made by this line with the normal to the hologram, where the angle of incidence of the replay beam is θ, is given by the relationship

$$\tan \alpha = \sin \theta$$

Figure 18.5 shows the relationship graphically. The actual figures are affected slightly by additional factors such as emulsion shrinkage and the distance of the replay source.

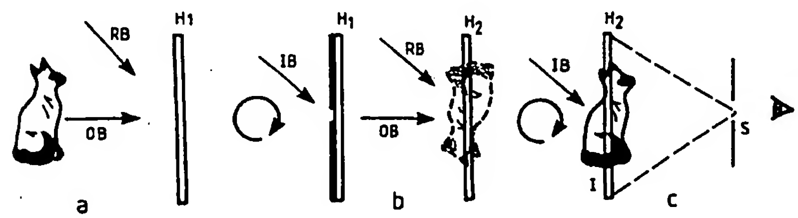

Fig. 18.4 Slit transfer principle. (a) Transmission master hologram H_1. (b) H_1 flipped and masked by horizontal slit. Image beam IB becomes object beam OB to make image-plane transfer H_2. (c) H_2 flipped and illuminated by laser image beam IB creates hologram-plane image and image of slit at original distance. Image I is visible only from position of slit image S.

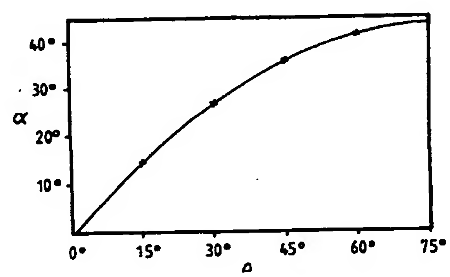

Fig. 18.5 Graph of α versus θ where $\alpha = \tan^{-1} (\sin \theta)$.

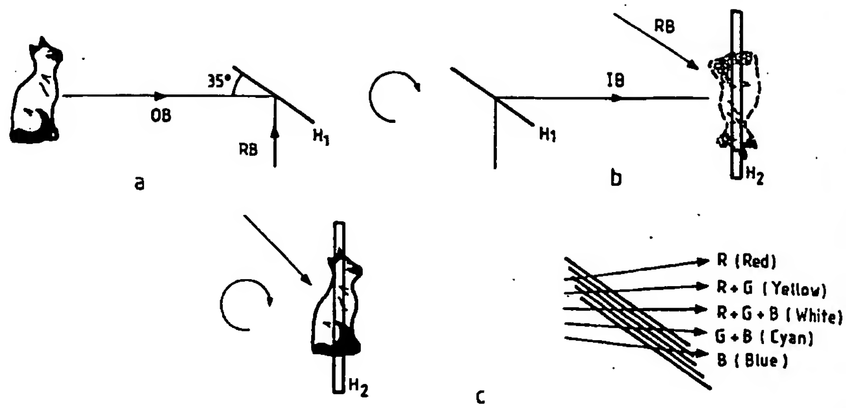

Fig. 18.6 (a) The master hologram H_1 is made at the achromatic angle for final reconstruction at 45°. (The reference beam is shown as orthogonal, though it does not need to be so.) (b) The flipped master H_1 is transferred. (c) When the transfer hologram H_2 is flipped and illuminated by a white point source, the images of the master hologram aperture are superposed in the same plane, 'slipped' so that the central view contains all wavelengths and the final image is achromatic, with some vertical parallax.

For the time being, we can assume that all the beams are collimated, and that the replay angle of incidence is to be 45°, so that the achromatic angle is 35.3° (35° is near enough).

We set the master hologram at this angle, with a reference beam coming from directly "below" (Fig. 18.6a). The hologram is processed in the usual way for transmission masters, and flipped to produce an image-plane transfer WLT hologram with a reference beam at 45° (Fig. 18.6b). This hologram, when again flipped and illuminated with collimated white light, produces an orthoscopic hologram-plane image and a real image of the master hologram in the viewing space, tilted at the achromatic angle of 35°. This image is in its geometrically correct position for the original laser wavelength, but is lower and further away for longer wavelengths. However, it will be in the same plane, just slipped down a bit, so that at the center point *all* the wavelengths are present (Fig. 18.6c) and the image is genuinely achromatic, over a vertical range of about 10°. As we shall see in the rest of this chapter, and even more in Chapter 19, the importance of this particular insight can scarcely be exaggerated. Indeed, the MIT team was sufficiently proud of it to commemorate it with a T-shirt printed with the crucial diagram (Plate 12) — perhaps the most esoteric blazon ever to appear on such a garment.

It has to be admitted that the register is not perfect. The achromatic 'plane' is in fact slightly curved, and the magnification changes from red (smallest) to violet (largest). But for fairly shallow images such as portraits the registration is good over about 25° each side of center, and there is a small but important amount of vertical parallax within the achromatic area.